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## Summary and Critical Issues in Tracking Foodborne Pathogens

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## Section VI

### Summary, Data Followup, and Recommendations

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## Summary and Critical Issues in Tracking Foodborne Pathogens

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### An Overview of Data Issues

In 1985, the National Research Council issued a report evaluating the scientific basis of the Nation's meat and poultry inspection program. The report focused on alternative strategies to assess and control risks from meat and poultry and to make food safety inspection more effective in protecting public health. Among the conclusions and recommendations was the need for a "rapid, timely, and flexible system to acquire, transfer, analyze, and make more widely available data related to inspection and to meatborne hazards." Data are needed to identify the nature and extent of the food safety problem arising from foodborne pathogens and to evaluate public and private management and control of microbial pathogens in meats and poultry.

In the last 10 years, there has been significant progress in developing scientific knowledge about foodborne disease, including improved tests to identify pathogens and advances in epidemiology for identifying control options. In some cases, traditional human illnesses have been newly linked to foodborne pathogens, and in other cases, new diseases and potential sources of contamination have been identified. This new scientific knowledge and increased public awareness of risks associated with pathogens in meat and poultry have led to calls for improved regulation-and information-on pathogenic microorganisms.

The policymakers at this conference emphasized the Federal Government's commitment to improving food safety. The Acting Under Secretary for Food Safety, Michael Taylor, said, "We want to forge a partnership with academia, Government agencies, and industry to obtain the data we need to bring us closer to our food safety goals." Hazard Analysis and Critical Control Points (HACCP) system regulations have been proposed to build

prevention into plant operations and to focus inspection on prevention objectives (Taylor, 1995). The U.S. Department of Agriculture (USDA) also has a commitment to designing interventions using the best possible risk assessment and cost-benefit analysis (Collins, 1995).

Furthermore, recent international agreements make regulation of food product trade subject to science-based standards. Thus, interventions will increasingly be under scrutiny for their ability to reduce measurable risk in the most cost-effective manner. Lonnie King, Acting Administrator of the USDA Animal and Plant Health Inspection Service, suggests that we ask, "How much safety can we afford?" rather than "What is safe?" The need to evaluate alternative and existing interventions creates a demand for better data, and this conference was organized to assess data needs for evaluating control options.

In this conference, the papers and discussion have addressed the development of a system of data to protect public health and to manage the risks from unsafe meat and poultry. The following discussion highlights seven issues that were identified in conference presentations and discussion.

First, the speakers and questions from the audience highlighted *the lack of agreement on estimates of the number of cases of human illness associated with foodborne pathogens*. The estimated deaths range from 525 to 9,000 annually, and specific food links are difficult to document. An exciting announcement at this conference was a new initiative by the Food Safety and Inspection Service (FSIS), Centers for Disease Control and Prevention (CDC), and Food and Drug Administration (FDA) (Hughes and Swerdlow, 1995, discussed in detail later) to investigate cases of reported diarrheal disease at sentinel sites in order to identify causative pathogens.

Second, conference speakers all highlighted *the need for an integrated approach to the collection and analysis of data*. The nature of food production today is complex, and the potential for contamination exists at all stages of processing. Thus, data that will help to identify control options must encompass the entire food system. Furthermore, data on foodborne pathogens need to be linked across different stages of the food system in order to provide a better understanding of how pathogen sources relate to illness outcomes. The papers in the last session presented frameworks, such as fault tree analysis, for organizing information from throughout the food chain. Such linkage requires interdisciplinary and interagency cooperation. The conference represents an important first step towards such cooperation.

Third, there are key gaps in available data of all kinds, but *the data gap is greatest between the farm and the consumer*. Historically, data collection and reporting mechanisms have been developed to collect information regarding food consumption and incidence of illness at the consumer level and to collect information regarding management practices at the farm level. These historical mechanisms serve as the basis for current efforts to collect data regarding the incidence of foodborne illness or of pathogens among farm animals. However, there are no comparable mechanisms for collecting data at the processing and retailing levels of the food chain. This gap makes it difficult to link data on the incidence of pathogens among animals with data on specific illness outcomes.

Fourth, *how information is interpreted and reported will influence public perceptions and demand for safer food*. In this regard, food safety data present a good news/bad news dilemma. In the short run, there may be more “bad news” if more information documents the extent of human illness related to foodborne pathogens. Seward states that the food industry does not want consumers to think about safety when they eat out. But, as several speakers mentioned, “We can’t manage what we can’t measure.” Furthermore, data collection can produce more “good news” about the success of control efforts. For example, listeriosis cases have declined, largely due to industry/Government control efforts (Tappero et al., 1995). Tensions over what information will be collected and how it will be reported need to be discussed and resolved.

A fifth and related issue is *the gap between public and private incentives to collect and report data*. Food safety information is a public good because it has value to the public generally, but it is too costly for each individual or firm to obtain independently (see Jensen and Unnevehr, 1995). The Government has a role in providing basic

information on the extent and origin of foodborne illnesses or in developing the basic science, such as pathogen-testing methodology, that facilitates information collection. While private industry has incentives to evaluate production processes and to develop new methods, both kinds of information are proprietary in nature. Industry may not have an incentive to share information that could be utilized to design public interventions (see Buchanan et al.).<sup>1</sup>

Sixth, *there needs to be consensus about how priorities will be set for data collection*. Priorities must be set because resources are limited and data are costly to collect, report, and analyze. Criteria are needed for deciding which foodborne pathogens are most important to control. Once these are identified, it becomes easier to prioritize data collection regarding control options. Because society has not reached consensus about who will bear the risks of foodborne illness and who will incur the costs of risk reduction, stakeholders may have different perspectives on which criteria are most important. Some proposed criteria for setting priorities are discussed below.

Seventh, *there are exciting new efforts underway and new opportunities to collect and utilize information*. As the demand for food safety information has increased, both public agencies and private industry are collecting new information. (A summary of publicly available data is found in Hamm, 1995). Both sectors are also developing new technologies—the public sector has invested in developing more rapid tests for pathogens, and industry has developed the clamshell cooker to assure better destruction of pathogens in hamburgers (see Seward, 1995). New methods of communication and analysis can reduce the cost of collecting, linking, or disseminating information. These opportunities may reduce the cost of developing an integrated data system.

In the remainder of this concluding paper, we first discuss how to set priorities for data collection, and then review highlights from the conference regarding key data gaps, new developments in data collection, and directions for the future.

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<sup>1</sup>Firms may have a disincentive to share information because of a fear that data on pathogen contamination in a plant or in food samples could increase the possibility of a successful liability suit. However, firms with a good pathogen control program can persuasively argue that they are doing an effective job of monitoring and controlling pathogens.

## Setting Priorities

Data and information are costly to gather. Furthermore, since pathogens differ in their entry points along the foodchain, the foods they are likely to contaminate, and their survival characteristics and responses to alternate control procedures, it is unlikely that one control technique will solve all foodborne disease problems (Council for Agricultural Science and Technology, 1994). Each pathogen must be examined individually to determine the most cost-effective strategies for control in the specific foods they contaminate. This need for pathogen-specific information increases the amount and cost of data needed to evaluate control options.

What criteria should be used to set priorities for collecting more data on foodborne pathogens? We assume that data are used to identify problems (for example, which foods are associated with which pathogens) and to estimate the benefits and costs of alternative solutions. It follows that data should first be collected for pathogens that pose the greatest problem, however defined. Roberts et al. (1995) advocate setting data collection priorities based on estimated economic costs to society of foodborne illness from specific pathogens. This collapses all acute and chronic illnesses and deaths into one number for the purpose of ranking priorities among pathogens and facilitates comparisons with the costs of alternative pathogen-reduction strategies.

Beyond setting priorities among pathogens, the general question we need to ask is, "What are the marginal benefits of better data on foodborne pathogens in being better able to evaluate alternative control procedures?" For example, using probabilistic scenario analysis, Griffin and Miller (1995) found that the bulk of the risk from the pine shoot beetle could be reduced by implementing one control strategy. The cost savings from not implementing the other 24 strategies, as planned by the State of Michigan, is a measure of the value of the information (see Roberts et al., 1995). Avoiding unnecessary or costly control options is one important reason to improve data collection.

If key gaps can be identified, putting more resources into generating data could be cost-effective. Since the human illness costs (medical costs and productivity losses) are currently several billion dollars (USDA FSIS, 1995) compared with Federal foodborne pathogen control programs that cost over \$1 billion (GAO, 1992), increasing spending to identify more explicitly the nature of the foodborne disease and control options could be very cost effective. And new technologies making data readily accessible in a cost-effective manner are becoming more widespread. The following section discusses the key data gaps identified in the conference papers.

## Key Food Safety Data Needs Identified

Conference papers identified a general paucity of data in the food safety area. While both industry and Government are undertaking new data collection efforts, remaining gaps are large. In summarizing the discussion, we define data needs to include research that would facilitate the collection of data through providing greater understanding of the nature of the food safety problem as well as specific information that could be collected through statistically valid surveys. For example, research to link foodborne illness to the existence of pathogens in farm animals is needed before surveys can be designed to monitor the incidence of pathogens and control measures at the farm level. These data and information needs fall into three broad categories: human health risk, the effectiveness of control options, and economic aspects of food safety policy options.

### Foodborne Disease Incidence and Human Health Risk

CDC's foodborne disease outbreak reporting system was not designed to establish incidence of illness but rather to alert the U.S. Public Health Service to large outbreaks of foodborne disease where public intervention would be required.<sup>2</sup> Discussion during the conference focused on four major problems with the data on the incidence of foodborne disease. First, there is *uncertainty about the magnitude of acute illnesses*. Estimates of acute illnesses range from 6.5 million to 33 million annually (Buzby, 1995). Second, there is *uncertainty about the distribution of disease severity for acute illnesses, especially deaths, and the incidence and severity of chronic illnesses* resulting from exposure to foodborne pathogens (see Buzby (1995)). Third, although there is generic identification of high-risk individuals, *little is usually known about the specific characterization of the pathogen or pathogenic mechanism* (Council for Agriculture and Technology, 1994). Studies identifying specific foodborne associations with disease in high-risk populations are few (see Steahr (1995) for one example). Finally, *foodborne illness data are not linked to specific foods*. There is no

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<sup>2</sup>Sporadic cases of foodborne illness in people's homes are only incidentally included in foodborne disease reports if: more than two people become ill, food is recognized as the cause, the cases are reported to the State or local health department, or the health department does an investigation confirming that food is the source and reports it to the CDC. To estimate the actual incidence of human foodborne illness, the CDC has occasionally conducted special studies, the latest by Bennett et al. (1986) on the incidence of infectious disease. In 1994, a CDC working group estimated that infectious diarrheas are the second most common infectious disease in the United States (respiratory infections are first).

systematic way of estimating how much foodborne illness arises from particular food sources (see Ralston (1995)).

### Data on Effectiveness of Control Options

The second major gap is information on the effectiveness of alternative control options. Hueston and Fedorka-Cray (1995) discuss two different ways to generate such information. One is through controlled experiments in a laboratory setting, which allow new control options to be evaluated. Another is through observational studies comparing microbial outcomes in different kinds of farms or firms, which permit the effect of existing management practices to be identified.

Laboratory experiments to control pathogens at specific levels of the production chain are rare. Their strength is clear identification of factors influencing pathogen control. But their findings may not apply in the less controlled environment of modern animal production and may not be cost-effective, since most of these studies lack information on economic feasibility.

Case-control studies are one kind of observational study where a pathogen-positive group is compared with a control group that is pathogen negative. Most case-control studies have been conducted to identify risk factors for human illness, and only a few have been conducted to identify risk factors related to hygiene and husbandry practices. One example is a Norwegian study that discovered that *Campylobacter* could be reduced by using chlorinated water in broiler houses (Kapperud et al., 1993). The strength of case-control studies is relatively rapid identification of economical and successful control techniques already used on some farms. Their weakness is a possible confounding of the results by unmeasured variables.

There are a few studies of the effectiveness of control options at the processing level, but they are scattered, and it is difficult to draw general implications from them for control strategies. Because many firms collect their own information, industry is a possible source of data on alternative control options. The adoption of HACCP may generate more data as firms monitor controls and keep records. Industry data at the processing level, however, depend on the unique product mix, sampling program, and reporting procedures characteristic of specific plants. Even if available, such data are hard to compare across firms. Furthermore, access to industry data is limited because of its proprietary nature and the legal liability potentially arising from pathogens in foods. As Bernard (1995) Kliebenstein (1995) and Buchanan et al. (1995) discussed, it may be possible to establish a clearinghouse for industry data that would provide confidentiality for firms and would standardize collection protocols.

### Economics of Food Safety Policy Options

Economic data can provide information to evaluate relative costs and benefits of alternative policy options. The development of economic information regarding costs and benefits depends on sound scientific evidence of the kind outlined in the previous sections, linking pathogen contamination to consumer illness and control options to reduction of specific pathogens. Economic models depend on scientific information to describe systemwide impacts of control options.

Several speakers advocated using multidisciplinary teams of social and physical scientists to solve food safety problems. Kliebenstein (1995) emphasized the need to use a systems approach for identifying the widest Possible array of solutions and estimating their impact. Buchanan et al. (1995) called for increased communication among disciplines. McDowell et al. (1995) discuss the interface among risk assessment, risk management, and economics.

To date, except for a few cost of illness and willingness to pay estimates, there are few data on the economic aspects of food safety. Data are needed that will allow comparison of costs of foodborne illness relative to the costs of control options. Cost of production data are available from a variety of sources for livestock production and processing. However, these data have not been linked to food safety outcomes. For example, industry census data can tell us the costs of slaughter and processing. But such data do not reveal whether plants are using HACCP or how costs and management techniques relate to the incidence of pathogens in products.

As economic data are developed, they would ideally signal the changes in costs to firms, benefits to consumers, and the payoffs from innovation in safety control. Economic indicators of food safety would allow comparison of costs and benefits of improving food safety in commonly denominated terms and would provide a signal of the relative willingness of the public to pay for additional food safety control (Jensen and Unnevehr, 1995). One example of such data might be indicators of the cost of illness, in aggregate and for specific pathogens. Other indicators might measure costs of control at different points in the production and distribution food chain. Indicators of potential risk from specific food sources would provide information with which to assess the distribution of risks to consumers, allowing education or regulatory control to address particular risks and problems of exposure.

Other economic information is needed on the costs of supplying various levels of food safety and the structure of costs (average and marginal) of using different

techniques to increase food safety. This includes information about the costs to firms of changing production practices, including the implementation of HACCP. The relative/marginal costs of control can be weighed against the marginal gains in food safety of the foods to obtain information on the cost-effectiveness of various strategies for food safety control. University, industry, and Government researchers can all contribute to the generation of this type of data. Estimates of consumer willingness to pay for safety, not generally known today, can provide measures of the degree to which costs of control will be met by consumers in paying higher prices.

### New Developments in Data Collection

Several new or emerging efforts to collect data on food safety were discussed at the conference. These provide exciting opportunities to address the key data gaps identified above.

At the consumer level, Hughes and Swerdlow (1995) discussed the FSIS/CDC/FDA proposal to establish sentinel county surveillance for diseases with diarrheal symptoms. This surveillance would identify cases where people consult a physician, identify causative pathogens, and develop national incidence estimates. Even with a small sample size, estimates of foodborne deaths would be more credible than at present. Selected pathogens, such as *Salmonella* and *Escherichia coli* O157:H7, would be targeted to determine the specific proportion of illness attributable to specific food items. Depending on the level of funding, identification of food production and food consumption risk factors may be identified. Some data might also be generated on chronic sequelae. This surveillance system would help meet some of the critical needs for incidence data. What will clearly remain outside the study are those foodborne diseases that do not generate diarrheal symptoms.

At the slaughterhouse level, microbial baseline data are being collected in FSIS and will provide a picture of the incidence of major pathogens by animal species (USDA, 1995). At the farm level, the National Animal Health Monitoring System (NAHMS), discussed by Hueston and Fedorka-Cray (1995), is beginning to provide a picture of the incidence of pathogens in farm animals.

Some efforts are underway to facilitate building a database on industry practices. The standardization of test procedures and methods is an important component of building data systems to evaluate control options. Efforts to standardize the protocols include: the AOAC International's approval of pathogen tests for both FSIS and FDA, the Food Safety Consortium's work by

research microbiologists who could aid in standardizing data collection methods and perhaps serve as a clearing-house for data collection, the National Advisory Committee on Microbiological Criteria for Foods' HACCP guidelines for production of various foods, the teaching of HACCP courses by several industry trade associations, and the Educational Testing Service tests on food handling procedures for restaurant employees.

The USDA Economic Research Service is undertaking an effort to construct food safety indicators from these data sources at all points in the food chain. Such indicators include updated and more comprehensive indices of the costs of foodborne illness. In constructing indicators for the food processing and farm sectors, existing cost data will be linked to microbial outcomes wherever possible.

New methods of communication make it possible to share and link data. Examples include the CDC's electronic communication for laboratory results and e-mail discussion groups/bulletin boards springing up on food safety topics.

### Directions for the Future

Some research now underway will greatly help to conceptualize and improve our understanding of foodborne pathogens. This research will facilitate data collection and utilization of existing data. For example, fault tree analyses (or probabilistic scenario analyses) can utilize data to identify high-risk food production, marketing, and consumption practices-critical inputs for performing benefit/cost analyses of alternative control strategies to reduce foodborne pathogens. Predictive microbiological modeling shows the food processing circumstances that enable pathogenic bacteria to survive and multiply, which can aid in identifying control points. Identification of the infectious dose for pathogens for different population groups would aid in designing control programs for high-risk populations.

New technologies may facilitate the development of data systems and exchange of information between the private and public sectors and within the research community. Through coordinated efforts on database development, it may be possible to set up a data coordination system organized by links in the food chain. For example, it may be possible to link existing or emerging data sets. An interesting question is whether trends in human illnesses, identified by CDC, will mirror trends in FSIS baseline data for specific pathogens and NAHMS data on the incidence of pathogens in farm animals.

Rapid changes in the technologies of gathering and coordinating data will reduce the cost of information. Cheaper, easy to use, more rapid tests to identify pathogens will facilitate control, both because more testing is likely to be a part of the food safety control system (USDA, 1995) and because such information increases the range of control options. For example, farm-lot sampling in slaughterhouses might make possible increased control of specific products or introduction of followup and feedback to the farm source. Technological improvements in testing and tracking food products from

farm to distribution are likely to change the nature, costs, and uses of data.

There was strong consensus at the conference that Government agencies, universities, industry, and consumers need to continue to work together in the area of food safety. Cooperation is needed to further identify the nature and extent of the food safety problem, to set priorities for data collection and research, and to integrate data collection and analysis along the food chain.

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